Environmental factors influencing the population viability of Sacramento River Winter Run Chinook salmon (*Oncorhynchus tshawytscha*).

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Abstract

The Sacramento river winter run chinook salmon *(Oncorhynchus tshawytscha)* population has declined from around 200,000 in the late 1960's to barely 8000 in recent years. The cause can be attributed to some combination of overfishing and environmental degradation in past years, but the relative magnitude of those effects has not been determined. We build a population dynamics model of the life history of Sacramento River winter run chinook salmon through fresh water and ocean stages. Using maximum likelihood techniques to fit the model to empirical data, and we find that environmental conditions and anthropogenic effects explain much of the variation in the stage-specific survival rates of the winter run. We find that accurate prediction of past escapements is possible when environmental effects are implemented as forcing variables for productivities and capacities. Environmental variables include: egg rearing temperatures above Red Bluff diversion dam, Bend bridge flow, striped bass *(Morone saxatilis)* abundance, a variation of the central valley harvest index, the number of days Yolo bypass remain open, sea level height, upwelling, October to March average PDO and sea surface temperature. Our model can be used to evaluate alternative management actions aimed at the recovery of this population. We reconstruct the population trends and forecast the abundance of the winter run in 2009 with a deterministic model that uses only the initial escapements from 1967 to 1970, where inter-annual variation in survival is completely driven by environmental effects. Our analysis indicates that under that under the status-quo, the population could recover to 12,000 by 2028, but even conservative policies that combine water resource management and harvest control can improve recovery to over 20,000 in that same time. It appears that recovery to 1960 levels is not possible given the changes in habitat and ocean conditions.